NASA SPoRT Training: GPM Precip Products

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Introduction

Training Objectives

- Describe key features about GPM swath rain rates and IMERG and how rain rates are derived
- Identify where you should have high/low confidence in the GPM products
- Apply GPM products in operations with complementary products
NASA GPM Mission Background

• **NASA GPM Mission purpose:**
  – observe global rainfall;
  – improve forecasts through assimilation and instantaneous precip info;
  – study the water cycle, water resources, precip microphysics, extreme weather events, climate sensitivity.

• **GPM Constellation**: international consortium of research and operational satellites that estimate rain and snow globally
Rain Rates from a Constellation

- Global coverage from several different satellites
- Temporal resolution varies and can be as high as several overpasses an hour
- Spatial resolution varies based on instruments and frequencies
How are Passive Microwave Rain Rates (RRs) Derived

- Rain rates inferred from brightness temperatures
- Lower frequency channels observe emission from liquid hydrometeors
  - Works best over oceans
  - Cannot easily distinguish cloud emissions from land emissions
- High frequency channels observe scattering off of ice in clouds
  - Works best for ice process (convection)
  - Preferred for land

Imagery from the COMET Program
How are RRs Derived

- Database incorporates GMI, DPR, model and surface obs.
- Observes brightness temps (Tbs) using Constellation of passive microwave instruments.
- Compares obs to database of observed precip profiles and associated Tbs from GPM core instruments to determine rain rates.
Passive Microwave Rain Rates

- Take advantage of unique capabilities
- Derive a rain rate product
  - SPoRT using data derived from the Global Precipitation Mission (GPM) science team

- GPM Microwave Imager includes higher frequencies for ice content
- Channel trade-offs
  - Lower frequency: Better cloud penetration
  - Higher frequency: Better resolution

37 GHz: Intensity and areal extent and at lower levels

89 GHz: Intensity and identifying storms with high ice content

Rain Rate: Inches per hour
Quiz

• GPM rain rates...
  – Come from a number of intercalibrated passive microwave instruments on different satellites
  – Were designed for research
  – Are derived by comparing observations to an existing database of precip profiles
GPM Swath Rain Rate Product
Product Details - GPM Swaths

• Temporal and spatial resolution vary by instrument

• Coverage

• Access the imagery
  – Satellite menu in AWIPS
  – NASA-SPoRT’s Real Time Page: https://weather.msfc.nasa.gov/sport/
  – NASA Worldview: https://worldview.earthdata.nasa.gov/

1456 UTC SSMIS on F18
Utility in Operations

• Provides precip info in data-void regions and offshore
  – Where radar/gauges are unavailable or need supplementation
• Use in conjunction with IR to identify most intense convection
Product Application

Offshore precip in AJK area of responsibility

24-hr Accumulation
07 April 2016

GPM Rain Rates
07-08 April
(1656-0349 UTC)
Access Swath Rain Rates and Quiz

- Find “Global Precipitation Measurement” under “Real-Time Data” menu
- Go to “Passive Microwave”
- In “Zoom to a Region”, select “Alaska Region”

T/F: The “Alaska Region” domain of rain rates is displayed
F: Use the Previous/Next buttons to find an orbit over your region...THEN select “Rain Rate” in the “Regional” section
Access Swath Rain Rates - Worldview

- [https://worldview.earthdata.nasa.gov/](https://worldview.earthdata.nasa.gov/)
  - Click “Add Layer”
  - Select “Floods”
  - Select “Precipitation Rate”
  - Select as many data sources as you want.

Want NRT? Use one of these:
- GPM/GMI
- GCOM-W1/AMSR2
- DMSP-F17/SSMIS
- DMSP-F16/SSMIS

- Select date
GPM IMERG Products: Early and Late
Products

• 3 different gridded data products
  – “early” 4+ hour latency and is half-hourly
  – “late” 8+ hour latency and is half-hourly
  – “final” research/climate product with a two month latency; produced monthly

• 0.1 deg spatial resolution

• 60N-60S (global product forthcoming)
Application Example

IMERG can be used to:

- observe precip in data-void regions
- accumulate precip in synoptically significant time periods
- supplement existing data

transitioning unique NASA data and research technologies to operations
Product Details - IMERG

• First algorithm to fuse techniques from TMPA, CMORPH-KF, and PERSIANN-CCS
  – CMORPH-KF uses PMW instantaneous RR looking forward and backward in time and space
  – CMORPH-KF fills in with IR if PMW is older than 90 minutes
  – PERSIANN-CCS uses IR (Tb-RR relationship) in a neural networking scheme for Cloud Classification
Early and Late Products

• Same input data in both products
  – **Passive microwave** – derived rain rates from several satellites
  – GPM DPR+GMI (merged *passive MW/radar*)
  – **IR data** (GOES, NPP CrIS, AIRS, Meteosat, MTSat)

• Processing is different in the Early and Late products
  – Forward morphing in Early product
  – Forward/Backward morphing in Late product
  – Result: **IR data more prevalent in Early product**
Final Product

• Uses monthly gauge data
  – Modified spherical Shepherd scheme:
  – Result: accounts for distance and direction of propagation of precip
  – Gauge data calibrates Early and Late, but Early and Late do not have gauge data in them
Comparisons

- SPoRT working on study to compare Early, Late, Stage IV, and MRMS

Transitioning unique data and research technologies to operations
Transition of L3 IMERG Data to Forecasters

Due to latency, most useful for hydrologic applications to pinpoint areas of heaviest rainfall outside of radar coverage

Product used for post-event analysis of landslide event in the Juneau area on 18 August

Also used by Albuquerque WFO to analyze flash flood event in July
Validation

- So far, validation has occurred over CONUS in radar-covered locations (i.e., not complex terrain) during spring and summer (i.e., predominantly convection)
- Compares well to MRMS

PCMK is a gauge network
PrecipitationCal is IMERG
Access IMERG Rain Rates and Quiz

• [https://weather.msfc.nasa.gov/sport/](https://weather.msfc.nasa.gov/sport/)
  – Find “Global Precipitation Measurement” under “Real-Time Data” menu
  – Go to “IMERG” and “Early”

• T/F: Alaska is really well represented in the IMERG rain rates

• F: Currently, the IMERG domain is only from 60N-60S...but you can see incoming precip offshore
Access IMERG via SPoRT WMS

• [https://weather.msfc.nasa.gov/viewer/viewer.html?config=ak fireweather](https://weather.msfc.nasa.gov/viewer/viewer.html?config=ak fireweather)
• Can toggle products on and off from the pane on the left
• Animation mode...animate one product at a time
Validation

• WSR-88D vs DPR
  – DPR attenuates and underestimates convection
  – Stratiform cases match sources to within 1 dB
• Version 03 vs Version 04
  – V04 compares well with MRMS
  – V04 slight high bias but depends on precip mode
  – Light rain and heavy rain: overestimated
  – High lats: possible underestimates
Strengths

• Constellation improves spatial coverage and temporal resolution
• High frequency GMI channels better capture light rain events than predecessors
• PMW sees “through the clouds”, unlike IR which uses cloud top temps
Limitations-GPM Swath Rain Rates

• Inconsistent spatial resolution and temporal frequency among instruments
• Decreased coverage and frequency equatorward
• Latency of 1+ hours
• PMW retrievals have continuity problems along coastlines
Limitations-IMERG Rain Rates

• Currently limited to 60N – 60S
• Latency of 4+ hours (Early Product) and 8+ hours (Late Product)
transitioning unique NASA data and research technologies to operations

Quiz
Conclusions

GPM Rain Rate Products…

• Are from a constellation of satellites;
• Can supplement existing data;
• Are utilized in data-void and offshore regions.

Additional resources:

NASA-SPoRT
COMET training
GPM Mission Page
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